REMARKS

Claims 12 to 21 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirements. The Examiner is of the opinion that the expression "substantially maintaining the form of the blank" is not supported by Figs. 1 and 2 and the specification. The Examiner is of the opinion that Figs. 1 and 2 have shown necking on the blank which is significantly different from the previous form of the blank.

The examiner's objections are respectfully traversed. Fig. 1 of the instant application is a schematic drawing showing in principle a technical solution for the method according to the claimed invention, wherein the blank is subjected to a combination of twisting and compression (see also page 7, lines 6 to 9 of the application as filed). Fig. 1 does not show any modification of the form of the blank. The "necking" of the blank is not the result of the deformation, but it is the original form of the blank. During the deformation by torsion and compression, there is no tapering or necking, as can be clearly seen, *e.g.*, from Fig. 2.

Fig. 2 of the instant application is a photograph of a treated sample of the blank which had an original form showing tapering ("necking") towards its center. Thus, the necking is not due to the deformation by simultaneous torsion and compression, but it is the original form of the blank. The deformation zone is the dark area in the center of the blank, whereas the outer (polished) regions have not been deformed, and already show the same kind of tapering. Therefore, it is evident from Fig. 2 that the form of the blank was substantially maintained: only in the center of it, the diameter of the body increased slightly.

This is further corroborated by the description. Extrusion, such as shown in the applied Thomas, et al. patent, is discussed on page 3, lines 14 to 26. It is stated that the transformation degree achieved by extrusion is generally limited by the geometry of the desired body to a reduction in cross-section by about 10:1. Whereas the diameter of the cylindrical body using an extrusion ratio of 10:1 is changed by a factor of 3.3, the diameter of the body is only changed by a factor of 0.1 to 0.2 (see, *e.g.*, Fig. 2) with the claimed process. Thus, it is clear that with the present process, deformation of the blank is achieved by "substantially maintaining the form of a blank" in comparison to other deformation procedures, such as extrusion or forging.

Thus, the expression in claim 12 "substantially maintaining the form of the blank" is supported by Figs. 1 and 2 of the description of the present patent application.

Claims 12 to 20 are further rejected under 35 U.S.C. §103 as being unpatentable over U.S. Patent No. 5,262,123 (Thomas et al.).

The Examiner's rejection is respectfully traversed. Thomas et al. discloses a method of forming or reforming a composite material by extrusion (see, *e.g.*, abstract and figures). The material is extruded through a die while the plunger, that presses the material through the die, is rotated.

Extrusion does not substantially maintain the form of the blank. To the contrary, the blank is substantially deformed by the extrusion process, as can easily be gathered from the figures in Thomas et al. (*see* also previous discussion). Furthermore, extrusion after the claimed process has been excluded by replacing the wording "comprising" with "consisting of" in claim 12.

Thus, the difference between Thomas et al. and the claims is as follows:

Thomas et al. does not disclose that the form of the blank is substantially maintained.

The disadvantages of extrusion pressing are discussed on page 3, lines 14 to 26 of the present application. It is generally disadvantageous that substantially higher temperatures are required for the extrusion pressing in comparison to the present process. Materials like titanium aluminides, which are subject to oxidation and corrosion, must therefore be encapsulated for extrusion. This is complicated and expensive. It is an object of the claimed invention to provide a method for the treatment of metallic materials which provides for a much improved consolidation of the texture and which is also applicable to very brittle materials. These have been difficult to transform so far.

Applicants have analyzed (see enclosed exhibit) the microstructure of an unprocessed titanium aluminide (Fig. 1 of the enclosed exhibit), of an extruded titantium aluminide (Fig. 2 of the enclosed exhibit) and of a titanium aluminide that was processed

according to claim 1 by simultaneous compression and torsion (Fig. 3 of the enclosed exhibit). The figures show that after extrusion, as disclosed in Thomas '123, the material exhibits a pronounced banding of the microstructure. The bands consist of fine-grained and coarse-grained microstructural constituents. Obviously, also shear localization occurs leading to the formation of cracks in the direction of the local flow (arrows in Fig. 2). Subsequently, the extruded material was torsionally deformed at 1050°C through three revolutions while being simultaneously compressed to $\varepsilon = 50\%$, whereby the banding in the microstructure was almost completely removed (see Fig. 3 of the exhibit).

Thomas et al does not render it obvious to one skilled in the art to apply the claimed process, wherein the blank is simultaneously twisted and compressed, and where its form is substantially maintained, by eliminating the extrusion step, to obtain the improvement in microstructure which is shown in Fig. 3 of the present application and Fig. 3 of the enclosed exhibit.

Surprisingly, with the claimed method, the texture of the materials can be significantly improved, without extrusion, as evident from Fig. 3 of the present application.

Therefore, the claimed invention is novel and non-obvious over Thomas et al.

New claim 32 has been added that includes the added "consisting of" language, added to claim 12, and eliminates the "substantially maintaining the form of the blank" language. If this language (of new claim 32) is preferred, claim 12 will be cancelled and claims 13-20 will be made dependent on new claim 32.

Claim 21 is rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,262,123 (Thomas et al.), and further in view of JP 03285757.

The Examiner's objection is respectfully traversed. Also JP 03285757 relates to a process where the blank is extruded. Therefore, the same arguments, as above with regard to claims 12 to 20, apply for claim 21.

It follows that also claim 21 is novel and non-obvious over the prior art.

New claims 22-31 follow the language of claims 12-21, but substitute the language "without extrusion pressing" (which is distinguished from the claimed method at page 3, second full paragraph, and elsewhere throughout the specification). Since the specification distinguishes the claimed method from extrusion pressing, there is no new matter in adding "without extrusion pressing" to new claims 22 to 31, particularly since extrusion pressing clearly does not substantially maintain the form of the blank.

Since each of the prior art references requires extrusion, and for the reasons set forth above, it is submitted that new claims 22 to 32 patentably distinguish over the prior art of record.

It is submitted that all claims 12 to 32 are now of proper form and scope for allowance. Early and favorable consideration is respectfully requested.

A check in the amount of $120.00 is enclosed for a one month Extension of Time fee. The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed herewith to our Deposit Account No. 13-2855, under Order No. 30572/40755 from which the undersigned is authorized to draw.

Dated: September 29, 2005

Respectfully submitted,

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EXHIBIT – U.S.-Ser. 10/021,684

Report: Comparison of microstructure development during extrusion and hot working through torsional deformation superimposed by compression

Cast material of gamma titanium aluminide alloys generally suffers from coarse and inhomogeneous microstructures and strong segregation of the alloying elements. Thus, processing has to be aimed to refine the microstructures and to obtain a microstructural homogeneity as good as possible. In the following experiments, ingot material of an alloy Ti-45Al-8Nb-0.2C (at.%) has been used which showed a coarse lamellar microstructure with a grain size of some hundred micrometer (Fig. 1). From the ingot a cylindrical billet was machined and encapsulated into a steel can. The canned billet was heated to 1250 °C and extruded to a ratio of 12:1 into a round die. After extrusion the material exhibits a pronounced banding of the microstructure which is a common feature of extruded Ti aluminide alloys (Fig. 2). The bands consist of fine-grained and coarse-grained microstructural constituents. Obviously, also shear localization occurs leading to the formation of cracks in the direction of the local flow (arrows in Fig. 2). The extruded material subsequently was torsionally deformed at 1050 °C through three revolutions while simultaneously compressed to $\varepsilon = 50$ %. After this working step the banding in the microstructure almost completely was removed and a homogeneous fine microstructure was formed (Fig. 3). Also, no indications of shear localization or cracking were found in this material condition. The results of the experiments indicate that the interpenetration of shear processes resulting from the superposition of torsional and compressive deformation is beneficial with respect to the homogeneity of the microstructure and the avoidance of cracking.

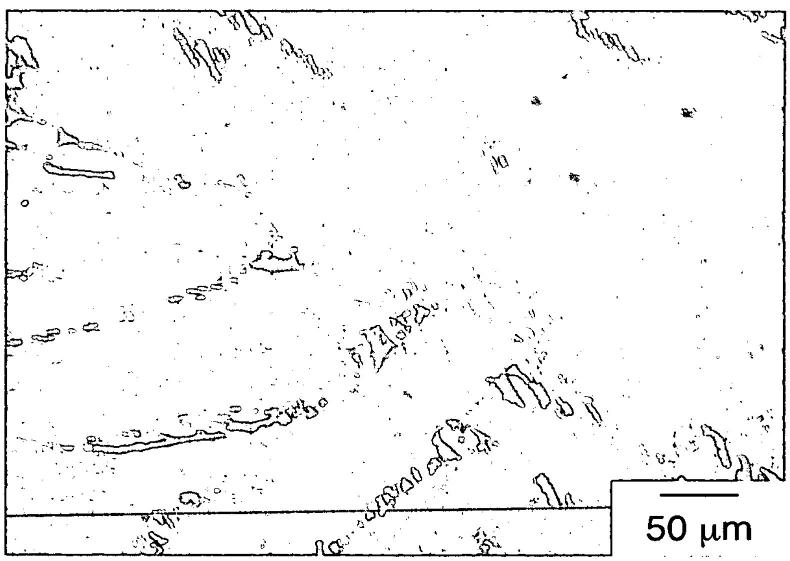

Fig. 1: Ingot microstructure of the alloy Ti-45Al-8Nb-0.2C (at.%). The micrograph was taken by scanning electron microscopy in the back-scattering electron mode.

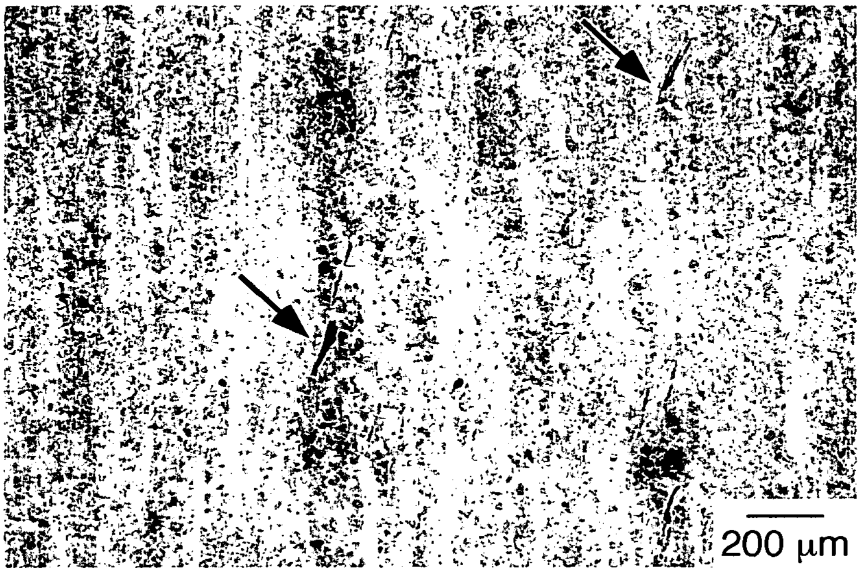

Fig. 2: Microstructure of the alloy Ti-45Al-8Nb-0.2C (at.%) after hot extrusion at 1250 °C to a ratio of 12:1. The extrusion direction lies vertically in the image. During extrusion shear localization occurred and led to the formation of cracks in the direction of the local flow (two examples indicated by arrows). The micrograph was taken by scanning electron microscopy in the back-scattering electron mode.

Fig. 3: Microstructure of the alloy Ti-45Al-8Nb-0.2C (at.%) after hot extrusion and subsequent torsional deformation through three revolution superimposed by simultaneous compression to $\varepsilon = 50$ %. The micrograph was taken by scanning electron microscopy in the back-scattering electron mode.

20.09.2005

Ihr Brief vom 14.09.2005
US-Patentanmeldung Nr. 10/021,684
Verfahren zur Behandlung metallischer Werkstoffe
Erfinder: Appel, Eggert, Lorenz, Oehring
Unser Zeichen: 694-11.01
Ihre Akte: P 67752

Sehr geehrter Herr Dr. Janssen,

vielen Dank für Ihren Brief zum Stand des US-Verfahrens der o.g. Patentanmeldung. Aus Sicht der Erfinder spricht nichts gegen den Entwurf für eine mögliche Eingabe an das US-Patent, vielmehr legt er überzeugend dar, dass die Anmeldung eine nachfolgende Extrusion ausschließt. Ebenso erscheint es uns sinnvoll, wie von Ihnen vorgeschlagen, die Ansprüche 22 bis 31 nicht weiter zu verfolgen.

Leider ist es uns nicht möglich, Ihrem Vorschlag folgend Beweise vorzulegen, die zeigen, dass das nachfolgende Strangpressen von bereits durch Torsion umgeformtem Material einen negativen Einfluss auf das Gefüge hat. Dieser Fall ist für uns technisch nicht von besonderem Interesse und es wurden bisher dazu keine Vergleichsversuche durchgeführt. Wir können allerdings zeigen, dass das Strangpressen von Titanaluminid-Legierungen zur Ausbildung streifiger Gefüge führt, wobei die Verformung in den Streifen stark lokalisiert wird (Fig. 2, beigefügter Report). Diese Lokalisierung der Verformung führt oft zur Bildung von Rissen in stranggepresstem Material (Fig. 2). Bei der Torsionsverformung überlagert durch Kompressionsverformung soll dagegen zum einen eine homogenere Verformung erreicht werden, indem sich Scherprozesse, die durch Kompressions- bzw. Torsionsverformung verursacht werden, nahezu senkrecht schneiden und das stark lokalisierte Fließen in einer Richtung vermieden wird. Zum anderen sollen durch die überlagerten Verformungsrisse auch Scherrisse in einem frühen Stadium wieder geschlossen werden. Beide Effekte werden in Abschnitt 0012 der US-Patentschrift dargelegt. Wie Fig. 3 in dem beigefügtem Report zeigt, lassen sich nach überlagerter Torsions- und Kompressionsverformung auch weder eine Bildung von Streifen im Gefüge noch Anzeichen für Verformungslokalisierung oder Rissbildung finden. Die Ergebnisse legen also nahe, dass mit dem in der Anmeldung vorgeschlagenem Verfahren bessere Gefüge als durch Strangpressen zu erreichen sind und sich das Risiko der Rissbildung im Vergleich zum Strangpressen reduzieren lässt. Es ist deshalb nicht sinnvoll, an das vorgeschlagene Verfahren noch ein nachfolgendes Strangpressen anzuschließen. Überdies würde dann auch der Vorteil verloren gehen, dass die Geometrie des Rohlings im wesentlichen erhalten bleibt.

Mit freundlichen Grüßen

M. Oehring